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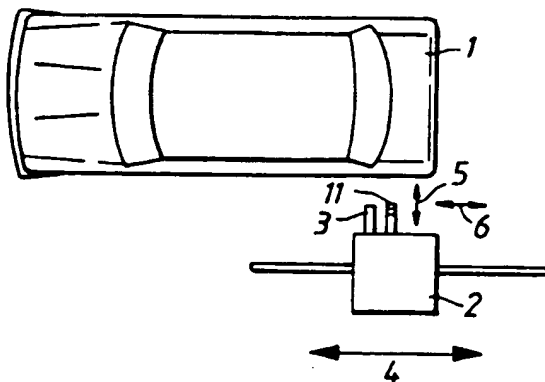
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INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

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<p>(21) International Application Number: PCT/SE93/00718 (22) International Filing Date: 3 September 1993 (03.09.93) (30) Priority data: 9202550-1 4 September 1992 (04.09.92) SE (71)(72) Applicant and Inventor: CORFITSEN, Sten [SE/SE]; Rådjursvägen 1, S-181 43 Lidingö (SE). (74) Agents: ÖRTENBLAD, Bertil et al.; Noréns Patentbyrå AB, Box 27034, S-102 51 Stockholm (SE).</p>		<p>(81) Designated States: AU, BR, CA, JP, US, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).  Published <i>With international search report. In English translation (filed in Swedish).</i></p>

(54) Title: APPARATUS FOR AUTOMATIC REFUELLING OF VEHICLES



(57) Abstract

Apparatus for the automatic fuelling of vehicles, primarily cars, comprising a robot (2) which includes a robot head (3) that is movable relative to the robot so as to enable it to be brought to a predetermined position in relation to the vehicle fuel-tank pipe, this positioning of the robot head being effected by means of a positioning system which includes a transceiver unit that is mounted adjacent the robot head, said unit preferably being constructed to operate at microwave frequency, and a passive transponder (13) which is placed in a predetermined position on the vehicle. The invention is characterized by a plurality of different transponders (13) of which only one is carried by a vehicle; in that each of said transponders (13) is provided with a simple code which the transponder is intended to modulate on a signal transmitted by the transceiver unit (14) and reflected by the transponder; and by a decoder (15) which functions to decode the code from the signal received by the transceiver unit (14) from the transponder (13) and delivers the code to a computer (23) connected to the robot; in that the computer (23) includes a memory in which a specific movement plan is stored for each code; and in that the computer is constructed to steer the robot head (3) in the movement plan defined by the received code.

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Apparatus for Automatic Refuelling of Vehicles

The present invention relates to apparatus for automatic refuelling of vehicles, primarily cars.

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An apparatus by means of which cars are fuelled automatically is described in Swedish Patent Specification No. 8901674-5.

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The apparatus according to this patent publication comprises a robot which includes a fuelling nozzle or corresponding device and which when the vehicle is placed in a predetermined position in relation to the robot is intended to move the refuelling nozzle automatically from a rest position to a vehicle fuelling position in response to sensing and control means. The

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fuelling nozzle includes a rigid first tubular element or tube which is intended to be moved by the robot towards an adapter provided with a hole which belongs to the vehicle fuelling location. A flexible, second tube is arranged for movement within the first, rigid tube from a first end position in which the outer free end of the second tube is located within the first tube, to a second end position in which the second tube projects out from the first tube. A tube connection is provided between said hole and the vehicle fuel-tank pipe. The robot is constructed to move the free end of the second tube out of the first tube and down into said tube connection, or down into the vehicle fuel-tank pipe, and pump fuel through the second tube down into the tank of the vehicle.

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Swedish Patent Specification No. 9001575-1 describes a method of opening and closing a vehicle fuelling flap which lies flush with the vehicle chassis and which can be swung between an open and a closed position around a vertical or horizontal axis and which covers the space in which the inlet orifice of the fuel-tank pipe is located. According to this patent publication,

the flap, or cover plate, is opened in two stages and different opening means are used in each of said stages.

5 One problem is that a large number of mutually different fuel-tank flaps exist and that these flaps are positioned in mutually different places. The problem is that it is necessary for the robot head to perform many different movements when a flap opening device is  
10 manoeuvred by means of robot head movement.

According to the last-mentioned patent publication, a vehicle-mounted transponder which coacts with a transceiver unit fitted to the robot head contains information relating to the particular pattern of movement  
15 that is to be carried out by the robot head in the case of the vehicle concerned at that time. The transceiver unit also coacts with the transponder to initially position the robot head in relation to the  
20 vehicle.

It is desired to simplify the opening process and to render those parts of an automatic fuelling system that are fitted to the vehicle less expensive.

25 These desiderata are fulfilled by the present invention.

Thus, the present invention relates to an apparatus  
30 for the automatic fuelling of vehicles, primarily cars, comprising a robot which includes a robot head that is movable relative to the robot so as to enable it to be brought to a predetermined position in relation to the vehicle fuel-tank pipe, this positioning  
35 of the robot head being effected by means of a positioning system which includes a transceiver unit that is mounted adjacent the robot head, said unit preferably being constructed to operate at microwave frequency, and a passive transponder which is placed in a

predetermined position on the vehicle, wherein the robot head includes an outer tube and an inner tube which is housed within said outer tube and movable out of said tube, wherein the outer tube is intended to be  
5 docked with an adapter which is attached to the upper orifice of the fuel-tank pipe, and wherein subsequent to docking said outer tube, the free forward end of the inner tube is intended to be projected to a position down in the fuel-tank pipe, whereafter fuel is  
10 delivered through the inner tube, and wherein the robot head carries a flap opening device which functions to open a fuel-tank flap of a vehicle in response to movements of the robot head, the invention being characterized by a plurality of different transponders of which only one is carried by a vehicle; in  
15 that each of said transponders is provided with a simple code which the transponder is intended to modulate on a signal transmitted by the transceiver unit and reflected by the transponder; and is further  
20 characterized by a decoder which decodes the code from the signal received by the transceiver unit from the transponder and delivers the code to a computer connected to the robot; in that the computer includes a memory in which a specific movement plan is stored for  
25 each code; and in that the computer is constructed to steer the robot head in the movement plan defined by the received code upon the receipt of said code.

The invention will now be described in more detail  
30 partially with reference to exemplifying embodiments thereof shown in the attached drawings in which

- Figure 1 is a schematic view from above of a vehicle parked adjacent a robot of the kind concerned here;
- 35 - Figure 2 illustrates the rear of the vehicle from one side thereof;
- Figure 3 illustrates the front part of a robot head belonging to said robot, and an adapter attached to the upper orifice of the vehicle fuel-tank pipe;

- Figure 4 is a schematic illustration of a closed fuel-tank flap and a flap opening device;
- Figure 5 illustrates schematically a fuel-tank flap that has been opened by means of the flap opening device;
- Figure 6 is a vector diagram illustrating movement of the robot head when opening the tank flap; and
- Figure 7 is a block schematic which illustrates a transceiver unit and a transponder.

Figure 1 illustrates schematically a filling station in which vehicles, primarily cars 1, are refuelled automatically and which includes a robot 2 having a robot head 3 which is movable relative to the robot so as to enable the robot head to be brought to a predetermined position in relation to the fuel-tank pipe of the vehicle. The robot may be movable in the direction of the arrow 4 and the robot head 3 is movable in the direction of the arrows 5 and 6 and also in a direction perpendicular to the plane of the paper.

The robot head 3 is positioned relative to the fuel-tank pipe 7 by means of a positioning system which includes a transceiver unit mounted adjacent the robot head, said transceiver preferably being constructed to operate at microwave frequency, and a passive transponder which is mounted at a predetermined location on the vehicle. There is preferably used a positioning system of the kind described in Swedish Patent Specification No. 8403564-1. By passive transponder is meant a transponder which receives a signal from the transceiver unit and retransmits the signal without adding further energy thereto, i.e. reflects the signal.

By predetermined location or position of the transponder is meant a position which is spaced at a given horizontal distance 24 and a given vertical distance 25 relative to the fuel-tank pipe 7.

Figure 3 illustrates the front part of the robot head in larger scale. The robot head 3 includes an outer tube 8 and an inner tube 9 which is movable within the outer tube, and out of said tube and the outer tube 8 is arranged for docking with an adapter 10 attached to the upper orifice of the fuel-tank pipe 7. When the outer tube is docked to the adapter, the free, forward end of the inner tube 9 is intended to be projected forwards to a position down in the tank pipe, whereafter fuel is delivered through the inner tube 9.

The robot head 3 also carries an opening device 11, which is shown in larger scale in Figure 4. The opening device 11 is constructed to open a fuel-tank flap or cover 12 of vehicle 1 in response to movements carried out by the robot head.

According to the invention, the system includes a plurality of different transponders 13, of which only one is carried by the vehicle 1, wherein each of the transponders is provided with a simple code which the transponder is intended to modulate on a signal transmitted by the transceiver unit 14 and reflected by the transponder. Figure 7 illustrates a transponder 13 with associated antenna, and a transceiver unit 14 and associated antenna. The transceiver unit includes a decoder 15 of suitable known kind which is intended to decode the code from the signal received by the transceiver unit from the transponder. The decoder is also intended to deliver the code to a computer 23 working with the robot. The computer 23 includes a memory in which a specific movement plan for each individual code is stored. When the computer 23 receives a code from the decoder, the computer functions to steer the robot head in the movement plan belonging to the received code.

According to one preferred embodiment of the invention, each of the transponders 13 includes a modulator 16 which functions to modulate the received signal with a frequency which is specific to each transponder and which forms the aforesaid code.

In this embodiment, the decoder is constructed in a known manner to detect from a number of different frequencies, namely equally as many frequencies as the number of different transponders, that frequency with which the received signal is modulated, and to deliver to the computer a signal which discloses the code that belongs to the detected modulation frequency.

According to another alternative and preferred embodiment, each of the transponders 13 includes a modulator 16 and also a pulse train generator 17 which is intended to steer the modulator 16 to modulate the received signal with a pulse train which is specific to each transponder 13 and which forms said code. The communication technique described in Swedish Patent Specification No. 7503620-2 can be used advantageously with this embodiment. The pulse train may contain the relevant code in binary form, which is preferred.

It can be said generally that this type of communication technique per se is well known to the art, among other things from the aforesaid patent specifications, and consequently the technique will not be described in greater detail in this document.

The aforesaid opening device 11 includes a resilient bellows-like element 18 which is mounted for pivotal movement on a shaft 20 against a spring force exerted by a spring 19, said pivot shaft being located at right angles to the plane in which the robot head moves during an opening operation. The shaft 20 will thus normally extend vertically. In its rest position, the bellows-like element 18 extends parallel with the



outer tube 8 of the robot head. The front, free end 21 of the bellows-like element 18 is open, whereas its other end 22 is connected to a suitable, known sub-pressure source, not shown.

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In Figure 4, the opening device is shown in a position to which it has been brought by the robot head and in which the front end 21 of said element 18 abuts a vehicle fuel-tank flap or cover plate 12, i.e. a position in which the opening operation shall commence.

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An opening and docking sequence is effected in the following way: The vehicle is placed in a predetermined position in relation to the robot, although reasonable deviations from this predetermined position are allowed. The robot is then started and the transceiver unit on the robot seeks the transponder and the robot computer steers the robot and its robot head to a position in which the antenna of the transceiver unit is positioned very close to the transponder antenna. This is the starting position. The robot thereafter reads the code that is relevant on this occasion and the robot computer then converts the code into a movement plan taken by the robot computer from its memory. Subsequent hereto, the robot computer controls movement of the robot head in accordance with this movement plan, in which the opening device is moved to the position shown in Figure 4 by means of the robot head. A subpressure is then generated in the bellows-like element 18, therewith causing the element to be sucked firmly to the fuel-tank flap.

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The robot head then continues to move in accordance with said movement plan, which is exemplified by the vectors shown in Figure 6. The vector 140 shows that the last movement performed prior to reaching the position illustrated in Figure 4 involved moving the robot head straight towards the fuel-tank flap through

a distance of 140 millimeters, so as to bring the bel-  
lows-like element into abutment with the fuel-tank  
flap. The robot head then moves through a distance of  
110 millimeters in a direction represented by the  
5 centre vector, and finally through a distance of 75  
millimeters straight to one side, as represented by  
the vector shown to the right in Figure 6. Upon com-  
pletion of this movement pattern, the position shown  
in Figure 5 will have been reached and the fuel-tank  
10 flap thus opened.

The mutual positioning of the outer tube 8 and the  
opening device on the robot head is such that the  
outer tube will be positioned centrally opposite the  
15 adapter 7 when the position shown in Figure 5 is  
reached.

The next movement carried out by the robot head is to  
dock the outer tube 8 onto the adapter, whereafter the  
20 inner tube 9 is moved down into the fuel-tank pipe of  
the vehicle. Fuelling is effected by delivering fuel  
through the inner tube and down into the tank pipe.

When fuelling is completed, the aforesaid movement  
25 pattern is repeated in the reverse order, so as to  
close the tank flap and return the robot to its origi-  
nal starting position.

In the case of the embodiment illustrated in Figures 4  
30 and 5, the tank flap is pivoted about a vertical shaft  
provided at one edge of the flap. It will be under-  
stood, however, that the movement plan stored in the  
computer memory may be one for opening flaps which are  
pivoted about a vertical shaft and flaps which are  
35 pivoted about a horizontal shaft or about a shaft  
having some other orientation.

The transponder can be placed in any given position  
whatsoever adjacent to or on the tank flap, since

after the robot head has sought the transponder so as to place the antennas of the communication link close together, i.e. in said starting position, the code will disclose a movement plan which causes the robot head to place the opening device in the position shown in Figure 4.

It will have been understood that because the movement plan associated with respective codes is stored in the robot computer, there can be stored a large number of movement plans which will cover in practice the movement plans required for automatic refuelling of all types of vehicles.

The amount of information contained in each transponder is very low, which means that the transponders can be made very simple and inexpensive in manufacture.

Although it is possible to store a movement plan for each vehicle per se, it is probable that five to fifteen different movement plans will be sufficient, because a given movement plan related to a given vehicle can be used for another vehicle. This means that only five to fifteen different transponders need be provided in order to serve essentially all types of vehicles.

According to one preferred embodiment of the invention, the transponder is placed on the vehicle so as to be positioned centrally opposite the transceiver antenna on the robot head subsequent to having docked the robot head onto the adapter. Thus, when the robot head has completed that part of the movement plan in which docking is effected, the communication link will be in said starting position.

This embodiment is particularly preferred for vehicles which do not have a stable height position immediately after switching-off the engine. The Citroen is an

example of such a vehicle. The embodiment is also beneficial to vehicles which are lowered by an extent in excess of about 2 to 3 centimeters when filling the fuel tank to its full capacity.

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Because the communication link is located in its starting position after docking, the robot computer may be programmed to control the robot head during the progress of a fuelling operation in a manner to maintain said starting position, thereby causing the robot head to accompany vertical movements of the vehicle, and therewith also of the adapter. The fact that the robot head shall be controlled in the aforesaid manner is disclosed by the transponder code, which means that in addition to taking-out a given movement plan, the computer also has to take-out instructions for guiding the movements of the robot head during an ongoing refuelling operation in the aforesaid manner.

20 It will be evident from the foregoing that the technique described above considerably simplifies both transponder and opening procedure in comparison with earlier known techniques.

25 Although the invention has been described with reference to several exemplifying embodiments thereof, it will be obvious that these embodiments can be modified by the person skilled in this art.

30 The present invention shall not therefore be considered restricted to the aforescribed and illustrated embodiments, since modifications and changes can be made within the scope of the following Claims.

Claims

1. Apparatus for the automatic fuelling of vehicles,  
primarily cars, comprising a robot (2) which includes  
5 a robot head (3) that is movable relative to the robot  
so as to enable it to be brought to a predetermined  
position in relation to the vehicle fuel-tank pipe,  
this positioning of the robot head being effected by  
means of a positioning system which includes a trans-  
10 ceiver unit that is mounted adjacent the robot head,  
said unit preferably being constructed to operate at  
microwave frequency, and a passive transponder (13)  
which is placed in a predetermined position on the  
vehicle, wherein the robot head includes an outer tube  
15 (8) and an inner tube (9) which is housed within said  
outer tube and movable out of said tube, wherein the  
outer tube (8) is intended to be docked with an adapt-  
er (7) which is attached to the upper orifice of the  
fuel-tank pipe, and wherein subsequent to docking said  
20 outer tube, the free forward end of the inner tube is  
intended to be projected to a position down in the  
fuel-tank pipe, whereafter fuel is delivered through  
the inner tube, and wherein the robot head (3) carries  
a flap opening device (11) which functions to open a  
25 fuel-tank flap (2) in response to movements of the  
robot head, c h a r a c t e r i z e d by a plurality  
of different transponders (13) of which only one is  
carried by a vehicle; in that each of said transpond-  
ers (13) is provided with a simple code which the  
30 transponder is intended to modulate on a signal trans-  
mitted by the transceiver unit (14) and reflected by  
the transponder; and by a decoder (15) which functions  
to decode the code from the signal received by the  
transceiver unit (14) from the transponder (13) and  
35 delivers the code to a computer (23) connected to the  
robot; in that the computer (23) includes a memory in  
which a specific movement plan is stored for each  
code; and in that the computer is constructed to steer

the robot head (3) in the movement plan defined by the received code upon the receipt of said code.

5        2. Apparatus according to Claim 1, c h a r a c -  
t e r i z e d in that each of the transponders (13)  
includes a modulator (16) which modulates the received  
signal with a frequency which is specific to each  
transponder and which forms said code.

10       3. Apparatus according to Claim 1, c h a r a c -  
t e r i z e d in that each of the transponders (13)  
includes a modulator (16) and a pulse train generator  
(17) which functions to modulate the received signal  
with a pulse train which is specific to each individu-  
15 al transponder and which forms said code.

20       4. Apparatus according to Claim 1, 2 or 3, c h a r -  
a c t e r i z e d in that the opening device (11)  
includes a resilient bellows-like element (18) which  
is mounted on a shaft (20) for pivotal movement  
against the action of a spring force, said pivot shaft  
being positioned perpendicularly to the plane in which  
the robot head (3) moves during an opening operation,  
wherein in its rest position the bellows-like element  
25 (18) extends parallel with the outer tube (8) of the  
robot head (3); and in that the forward, free end (21)  
of the bellows-like element is open, whereas the other  
the (22) of said element is connected to a subpressure  
source.

30       5. Apparatus according to Claim 1, 2, 3 or 4,  
c h a r a c t e r i z e d in that the transponder  
(13) is placed on the vehicle in a position such that  
said transponder will be located centrally opposite  
35 the antenna of the transceiver unit (14) on the robot  
head (3) when the robot head (3) is docked with the  
adapter (7).

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Fig. 1

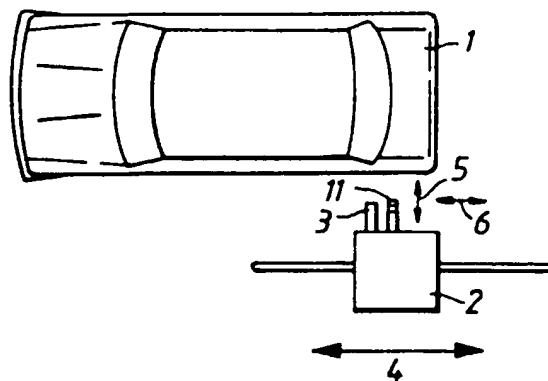


Fig. 2

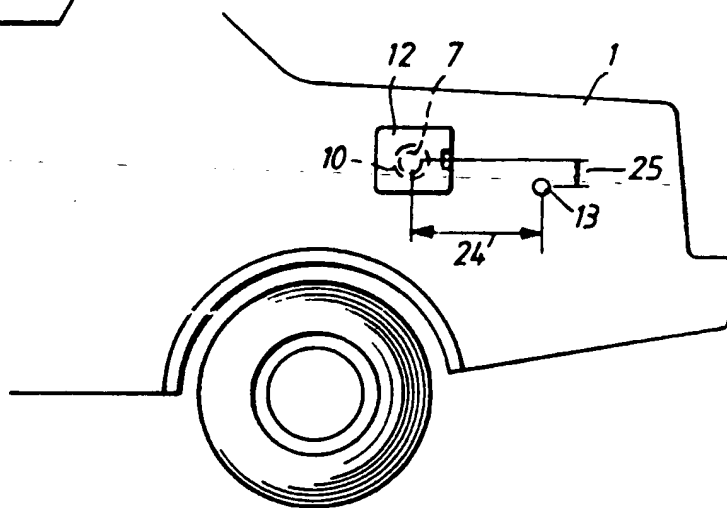
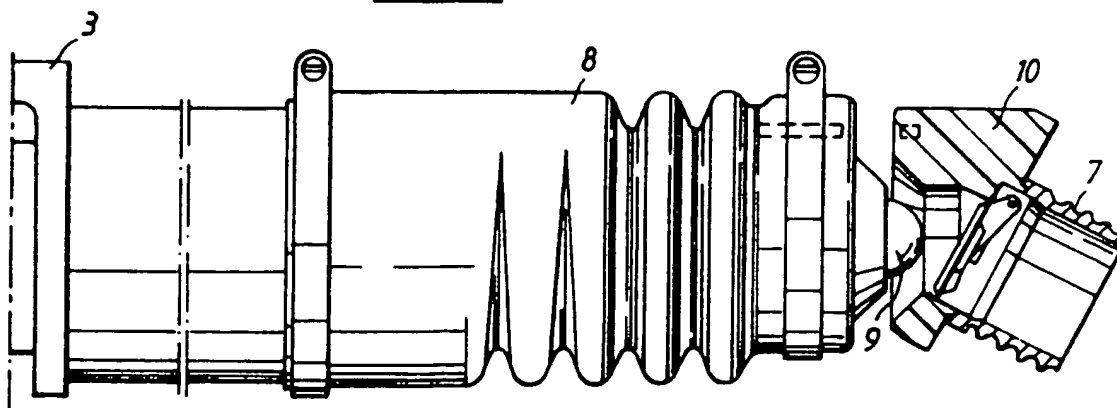
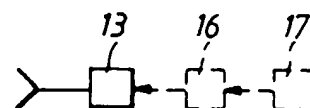
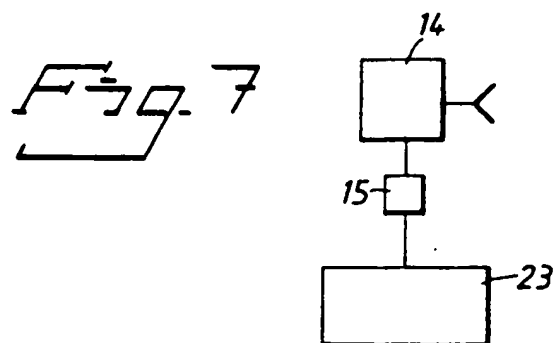
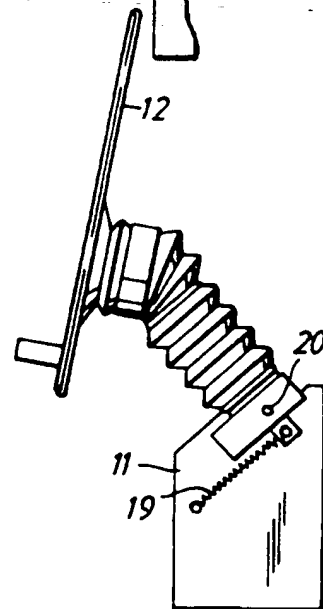
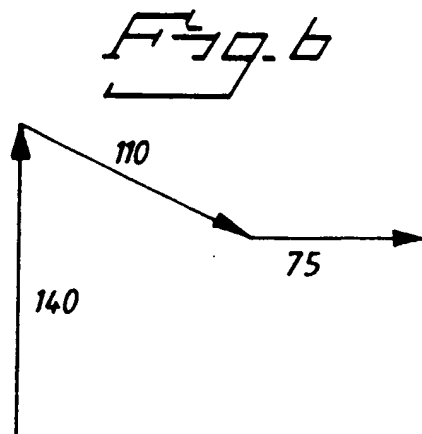
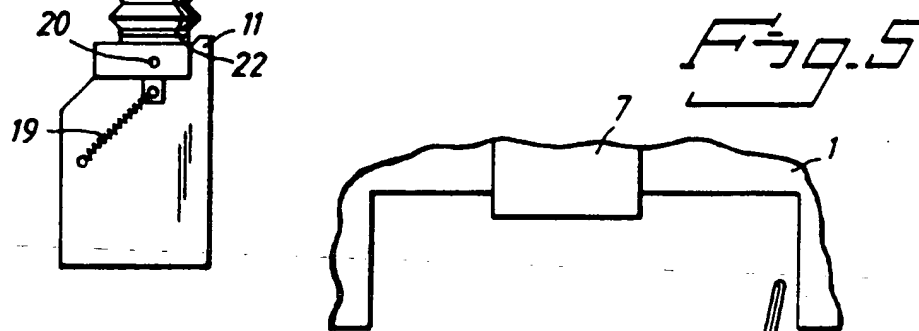
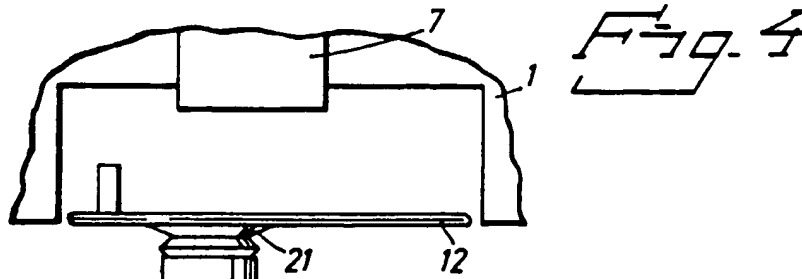


Fig. 3



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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/SE 93/00718

## A. CLASSIFICATION OF SUBJECT MATTER

IPC5: G01S 13/74, B67D 5/08, B60S 5/02

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC5: B60S, B67D, G01S

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	WO, A1, 9013512 (CORFITSEN, STEN), 15 November 1990 (15.11.90), page 7, line 13 - page 8, line 14, figures 1,3	1
Y	WO, A1, 9117111 (CORFITSEN, STEN), 14 November 1991 (14.11.91), page 3, line 12 - page 4, line 24, figure 1	1
Y	US, A, 3536109 (IRWIN GINSBURGH ET AL), 27 October 1970 (27.10.70), column 2, line 36 - line 46; column 3, line 20 - line 62, figure 1	1

☒ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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## INTERNATIONAL SEARCH REPORT

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## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	EP, A2, 0418744 (ETS ELEKTRONIK GMBH), 27 March 1991 (27.03.91), column 3, line 47 - column 4, line 34; column 12, line 26 - line 40, figure 5  --	1
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**INTERNATIONAL SEARCH REPORT**  
Information on patent family members

16/10/93

International application No.

PCT/SE 93/00718

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US-A-	3536109	27/10/70	NONE		
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